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DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange among interested persons of information concerning recent developments in various digital computer projects. Distribution is limited to government agencies, contractors, and contributors.

OFFICE OF NAVAL RESEARCH · MATHEMATICAL SCIENCES DIVISION

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COMPUTERS AND DATA PROCESSORS, NORTH AMERICA

1604 COMPUTER - CONTROL DATA CORPORATION - MINNEAPOLIS, MINNESOTA

The 1604 is an all-transistorized, stored program, general purpose digital computer possessing a large storage capacity, exceedingly fast computation and transfer speeds, and special provisions for input-output communication. In addition to communicating with standard peripheral equipment such as magnetic tape units, card readers, punches, and printers, the 1604 can also be used for control or communication in radar and sonar systems, real-time instrumentation systems, high-speed digital communication systems, and special display and output systems.

The computer features: parallel, binary mode of operation; 48-bit word length; 32,768 words of individually addressable core storage; 6.4 microseconds word-cycle time, 2.2 microseconds read-access time, 4.2 microseconds write-restore time, and 7.2 microseconds add time including access (av.); read-write overlap feature to increase word-cycle rate; single address logic, two instructions per 48-bit word; instruction format, operation - 6 bits, index designator - 3 bits, and base execution address - 15 bits; 6 index registers of 15 bits each; a repertoire of 62 instructions with many sub-instructions; indirect addressing; program interrupt; internally programmed real-time clock; versatile input output facilities, three 48-bit buffered input channels, three 48-bit buffered output channels, one high-speed 48-bit input transfer channel, and one high-speed 48-bit output transfer channel; translated contents of all operational registers displayed as Arabic numerals (octal format); highly reliable, conservatively operated transistor-diode logic circuits; low power consumption and heat dissipation; designed for ease of maintenance and testing; and small size - may be arranged in an area of 20 square feet.

The storage section provides high-speed, non-volatile, random access storage for 32,768 words. Size options of 8,192, or 16,384 words are available. The core storage section is controlled by a two-phase timing system, each phase controlling one-half of the total available storage. All odd storage addresses reference one storage unit, and all even storage addresses reference the other storage unit. The read access time of each section is 2.2 microseconds, after which, without delay, the next arithmetic operation is initiated. The storage cycles of the two sections overlap one another in the execution of a program with the result that the effective cycle time is 3.2 microseconds when consecutive addresses are referenced. The average effective cycle time for random addresses is about 4.8 microseconds for a representative program.

The instruction repertoire contains a flexible list of 62 instructions which expand into many sub-instructions. These 62 instructions provide fixed binary point arithmetic (integer and fractional), floating binary point arithmetic, logical and masking operations, normal arithmetic operations modulus 2^{48} minus one (one's complement), indexing, memory searching, input-output, sequence control (conditional and unconditional), and multiple precision capability. Some of the special programming features include ease of handling constants, indirect addressing, four search instructions, high-speed input-output transfers, buffering, external function, program interrupt, and a large group of logical commands.

Input-output operations in the computer are carried out independently of the main computer program. When transmission of data is required, the main computer program is used only to initiate an automatic cycle which buffers data to and from the computer memory. The main computer program then continues while the actual buffering of data is carried out independently and automatically.

The input-output section contains the facility for several modes of communication. For normal exchange of data with peripheral equipment, independent control is provided for the transfer of data via three 48-bit input and three 48-bit output channels asynchronously with the main computer program. For high-speed communication, one 48-bit input transfer channel and one 48-bit output transfer channel are provided. Communication control is performed by the external function instruction. In addition, the interrupt feature provides requests from peripheral equipment to the computer.

In normal input-output operations, the buffer control continually interrogates all communication channels to determine if a peripheral equipment is ready to send or receive information.

If a peripheral equipment has data ready for transfer, interrogation waits momentarily while a word is being buffered. The buffer control then resumes interrogating the communication channels. Buffering initiates communication between computer memory, the three buffer input channels, and the three buffer output channels. These buffer information in and out asynchronously with the main computer program. The three buffered input channels and the three buffered output channels, the interrupt line, and the real-time clock are rapidly scanned by a scanner which looks for action requests from all channels. These action requests are initiated by the peripheral equipment via indicator "flags." A complete scan of all communication channels is made in 3.2 microseconds, which corresponds to the phase rate of magnetic core memory.

High-speed input-output transfer of information between 1604's, or between one 1604 and peripheral equipment having comparable speed, is performed under control of the main computer program. Only one instruction is required for a block of input or output data. A 48-bit word is transferred in or out in 4.8 microseconds.

Input-output equipment available with the computer includes console input-output equipment and optional input-output equipment. The console equipment is standard with every 1604 and provides a 350-character per second transistorized Ferranti 7-level photo-electric paper tape reader, a 60 character per second Teletype BRPE paper tape punch, and a monitoring electric typewriter for making computer entries and for presenting typed copy. Optional equipment includes the Model 1607 Magnetic Tape System and the Model 1605 Adaptor.

A 1607 magnetic tape system consists of four Ampex magnetic tape handlers. The system is self-contained in a single cabinet, including data-handling and control circuitry; 48-bit assembly and disassembly registers; parity bit assignment for each written character; parity bit read-check immediately following each character written; longitudinal parity bit generation and recording at end of block; parity bit detection for each character read; and end of tape sensing. A number of 1607 magnetic tape systems can be attached to a 1604 computer. Simultaneously among these 1607 tape systems, three tape handlers can be reading, and three tape handlers can be writing. Each 1607 system has the facility for simultaneously reading from one tape handler and writing on one tape handler, while the remaining two tape handlers are rewinding. Magnetic tapes of the 1607 tape system are compatible electrically and mechanically with IBM Model 727 magnetic tape handlers.

The 1605 adaptor permits communication between the 1604 computer and any of the following IBM peripheral equipment: 714 Card Reader (via 759 Control Unit), 727 Magnetic Tape Units (via 754 Synchronizer), 717 Line Printer (via 757 Control Unit), 722 Card Punch (via 758 Control Unit). The 1605 selects one of these peripheral equipments as well as the operation to be performed, on the basis of an instruction from the main computer program. A parity check is made on all information transmitted from the 1605 to peripheral equipment. Each 1605 adaptor can be connected to any of the three buffer input and three buffer output channels, and each 1605 is independently addressable. The 1605 has the same 48-bit input and output buffer register characteristics as the 1607 magnetic tape system. A number of 1605's together with a number of 1607's can be operated with a single 1604 computer.

The first production computer has been completed and will be placed in operation this month at the U. S. Naval Postgraduate School, Monterey, California.

1401 AND 1620 SYSTEMS - IBM CORP. - NEW YORK, NEW YORK

1401 System. The all-transistorized IBM 1401 Data Processing System features electronic data processing for smaller businesses that have been previously limited to the use of conventional punched card equipment. These features include: high speed card punching and reading, magnetic tape input and output, high speed printing, stored program, and arithmetic and logical ability. The elements of the basic system are the 1401 Processing Unit, 1402 Card Read-Punch, and 1403 Printer. Configurations include a card system, a tape system, and a combination of the two.

The 1401 Processing Unit controls the entire system by means of its stored program. It performs the arithmetic and logical functions, controls card reading and punching, magnetic

tape input and output, and printer. The Unit automatically edits the system's printed output for spacing, punctuation and format. Memory is available with 1,400; 2,000; or 4,000 positions of core storage. Alphabetical or numerical data may be processed. The Processing Unit can perform 193,300 additions (eight-digit numbers) or 25,000 multiplications (six-digit numbers by four-digit numbers) per minute.

The 1402 Card Read-Punch reads information into the processing unit, punches cards, and separates them into radial stackers. Maximum speeds are: punching, 250 cards per minute; reading, 800 cpm. Reading and Punching can be performed simultaneously.

The 1403 Printer is a completely new development providing maximum "thru-put" of forms and documents in printing data from punched cards and magnetic tape. The printer incorporates a swiftly moving horizontal chain (similar in appearance to a bicycle chain) of engraved type faces, operated by 132 electronically-timed hammers spaced along the printing line. The impact of a hammer presses the paper and ink ribbon against a type character, causing it to print. The chain principle achieves perfect alignment of the printed line and greatly reduces the number of sets of type characters needed.

The unit prints by means of a scanning operation which compares characters on the chain with characters in storage designated to be printed. When a character on the chain matches the one in storage, the hammer for that printing position is fired. The chain of engraved type faces moves across the face of forms or documents at a constant speed of ninety inches a second. Two interchangeable type styles are available for the chain.

An outstanding feature of the printer is the exclusive Dual Speed Carriage, which has the ability to skip over blank spaces on forms and documents at speeds far in excess of normal printing rate. This carriage skips the first eight lines at thirty-three inches per second, and beyond eight lines at seventy-five inches per second. Combined with a printing speed of 600 lines per minute, the result is a higher rate of output than is obtainable with many printers of greater line printing speed. The Printer can produce over 230 two-line documents, such as checks, per minute. This is equivalent to a printing speed of 4,800 lines per minute.

Up to six 729 Magnetic Tape Units (Model II or IV) may be added to the 1401 system for increased input, speed, and storage compactness. These are the same all-transistorized tape units used with the Series 700 and 7000 data processing systems. Either single or double density tapes are specified to provide processing speeds of 15,000 or 41,667 characters a second with the 729 II; 22,500 or 62,500 characters a second for the 729 IV.

<u>1620 Systems</u>. The 1620 Data Processing System is a powerful, small, stored-program computer designed for scientific research, engineering, and management science computations. Solid-state componentry and the most advanced computer circuits have been combined to achieve reliable, high-speed operation. Conventional decimal arithmetic is used, providing ease of communication between man and machine. Consisting of two modular units, a Central Processing Unit and a Paper Tape Reader and Punch, the system requires no more space than the average-sized desk or drafting table. No air-conditioning equipment is required, enabling installation and operating costs to be kept to a minimum.

The 1620 Central Processing Unit contains the Operator's Control Console, a modified IBM Electric Typewriter, the magnetic core storage unit, the arithmetic and logical unit, and related circuitry. The magnetic core storage unit has a capacity of 20,000 alphameric digits, each of which is individually addressable and can be made immediately available for processing. All data introduced into the system are placed in core storage as decimal digits. Alphabetic and special characters are handled automatically, with each being stored as two decimal digits. Variable field length is used—only those memory locations required to express a number are used. For example, only two positions in memory are required to express the number "twelve," whereas in computers with fixed word length, the same number would require the use of as many as ten positions of memory, eight of which would be zeros to extend the word to its fixed length. This important feature means that only useful data is stored in the memory, resulting in greater capacity and faster access and processing speeds.

The arithmetical operations of addition, subtraction, and multiplication are accomplished automatically by a table look-up method. Division is performed by an available sub-routine using existing arithmetic operations and logic. A programmer need write only one instruction to perform division. Additions and subtractions of five digit numbers are performed in 560 microseconds. This includes the access time required to make the data available, the arithmetical operation, and the storing of the result in memory. A similar multiplication problem would require 5.96 milliseconds. All internal operations are completely checked, as is all input-output data.

Information is introduced into the system by means of the 1621 Paper Tape Reader and/or the keyboard of the modified Electric Typewriter. The Paper Tape Reader reads eight-channel paper tape at the rate of 150 characters per second. Output devices are the 961 Tape Punch (included in the 1621 cabinet) and the Electric Typewriter. These units receive the processed data from core storage and prepare a punched paper tape or printed report of the information. The Tape Punch records data on the eight-channel paper tape at the rate of fifteen characters per second, while the typewriter prints automatically at the rate of ten characters per second.

A two-address instruction format reduces the number of instructions required to perform an operation, thus simplifying the programming of the system and reducing the amount of storage required. For example, a single instruction will locate, add, and store the sum of two numbers, or transmit from one location to another an entire record regardless of length. Programming can be accomplished easily with IBM's advanced programming systems—FORTRAN and Symbolic Programming System. In addition to these programming systems, a comprehensive library of mathematical and statistical routines are available. These include a matrix package, regression analysis, analysis of variants, solution of ordinary differential equations, linear programming, etc. Specific programs for the petroleum industry, public utilities, civil engineering, and optical firms also are available.

TRANSAC S-2000 - PHILCO CORP. - PHILADELPHIA, PENNSYLVANIA

With more TRANSAC S-2000 Systems (see DCN, April 1959) in production and operation, it has been possible to verify and improve original, conservative performance estimates on the basis of actual machine experience. Also, new components, previously under development, have now been added which greatly increase the flexibility of input-output operations.

Memory Access Time. Memory access time has been reduced from 12 microseconds to 10. The split cycle characteristics are the same. The read cycle is now 4 microseconds and the write cycle takes 6 microseconds.

Automatic Interrupt. Two types of program interrupt may be employed. The first is a "programmed interrupt" under control of the program. By interposing a unique instruction into the program at selected intervals, the system can interrupt one program to perform another of higher priority, and then return to complete the first program. The second interrupt is an "external" or "real-time" interrupt. The interrupt data and program may enter the System through either the input-output processor or the real-time channel. The interrupt may take place immediately or within a few microseconds depending on the requirements of the specific installation.

Multiple Processing. Some EDP Systems have a feature called simultaneous read, write, and compute which is somewhat similar to TRANSAC's multiple-processing technique. TRANSAC's modern design, however, is more powerful. While the central computer is computing, as many as nine input-output devices may be processing data simultaneously. Four of the nine may be magnetic tape units; four may be punched card units, high speed printers, and paper tape units; while the ninth may be either a paper tape unit or a real-time device. Each of the nine units may be reading or writing. These simultaneous operations are performed while the central computer is processing data because of a technique of optimizing Memory use called Memory-Sharing, plus the advanced electronic design of both the input-output processor and the universal buffer-controller.

Input-output Processor. The input-output processor is the interconnecting and control link between the central computer and the 16 input-output channels. Each channel couples either a magnetic tape unit or a universal buffer-controller to the central computer. The standard data-transfer rate over a channel is 90,000 alphanumeric characters per second. By means of a multiplexing technique, the input-output processor can connect any four of the sixteen channels to the central computer. The combined transmission rate is therefore 360,000 alphanumeric characters of 628,000 decimal digits per second.

The input-output processor is also used to simultaneously control four universal buffer-controllers. In this case, while transmission takes place between TRANSAC's memory and four tape units, any combination of four punched card readers and punches, high speed printers, and paper tape readers and punches may also be operating. Central computer time is only used when data is transferred between the memory and a buffer-controller. The operations of the punched card, paper tape, and high speed printing systems are, essentially, off-line when under the control of buffer-controllers.

Universal Buffer-Controller. The Universal Buffer-Controller represents the most significant increase in the flexibility and economy of the TRANSAC System. This one unit controls off-line conversions between any two media, or on-line communication between the central computer and any medium except magnetic tape. The input-output devices that may be operated with the buffer-controller include punched card systems, magnetic tape units, paper tape systems, and high speed printing systems. Any desirable device may be easily added to a buffer-controller.

Punched-Card System. The punched-card reading rate is 2000 cards per minute through a new photoelectric reading technique. The System may read or punch 51 or 80-column cards in either Hollerith or card-image mode. The standard Hollerith code used in most punched card installations is expanded so that all 64 TRANSAC characters can be punched and read. The translation from Hollerith code to TRANSAC code is automatic. The card image mode facilitates the handling of binary information and packs twelve bits or two TRANSAC characters in each column. Card-image mode also simplifies the use of punched cards prepared on different computers.

COMPUTING CENTERS

COMPUTATION LABORATORY - ARMY BALLISTIC MISSILE AGENCY - REDSTONE ARSENAL, ALABAMA

The Computation Laboratory is part of the Development Operations Division of the Army Ballistic Missile Agency. The Laboratory serves all of the command located at Redstone Arsenal in the area of digital computing, including both scientific and commercial type applications. Insofar as computing equipment is concerned, the Computation Laboratory is a mixed centralized and decentralized installation. It is composed of a central operation consisting of two IBM 704's, one 709, one 705, one Burroughs 205, and associated peripheral equipment.

Programming for the centralized facility is a closed-shop operation. The bulk of programming and all of the operation is done by the General Electric Huntsville Computer Center, which has a contract for the digital mission of the laboratory. The Huntsville Computer Center is a sub-section of the General Electric Computer Department located in Phoenix, Arizona.

In the decentralized operation, four Burroughs 205 computers, eleven Burroughs E-103's, four IBM 610's, and eight Royal McBee LGP-30's are located in various laboratories and Command segments for on-the-spot type calculations. Much of this programming is in the open-shop mode. The Computation Laboratory furnishes programmer assistance and manages the operation of the decentralized computers.

The 704's have 8,192 words of magnetic core storage, 8,192 words of drum storage and normally seven tapes on-line. The on-line 704 tapes are equipped with an IBM tape switching

device which permits either 704 to become a full ten tape 704 at the expense of the other 704, which is reduced to a four tape system.

The 709 has 32,768 words of core storage, a data synchronizer unit, and two channels with four tapes on each channel. The 705 is a ten tape Model II machine with 40,000 characters of core storage. In addition, it has a complete complement of input-output equipment consisting of a 714 card reader, 717 printer, and 722 punch.

Four of the Burroughs 205's are located at Redstone Arsenal and one is with missile firing operations at Cape Canaveral, Florida. All of the 205's are equipped with floating point, photo-electric paper tape readers, paper tape perforators, and Flexowriters. Four of the 205's have magnetic tape storage units and two of these systems have been modified to read and write Millisodic tapes. Three of the 205's have cardatron buffered input and output.

The peripheral equipment consists of three IBM 720-II high speed wire matrix printers, each capable of 500 lines per minute and one 730-II high speed wire matrix printer capable of 1,000 lines per minute. The peripheral equipment also includes one 774 tape data selector with column binary and one 714 peripheral card to magnetic tape converter.

UNIVAC MODIFICATION - THE FRANKLIN LIFE INSURANCE COMPANY - SPRINGFIELD, ILLINOIS

The Franklin Life Insurance Co. recently developed and installed a modification to their Univac I which makes the memory allocated to instructions appear approximately 50% larger to the programmer. The Overdrive modification permits the coding of all alphabetic instructions in the format of three instructions per line as opposed to the conventional two instructions per line. Used with minimum latency programming additional speed with Overdrive is also possible, since in many instances the additional instruction can be executed within the necessary major cycle existing between one beta time-on and the next.

The Overdrive modification is under programmer control so that conventionally coded programs need not be recoded. Franklin Life also plans to utilize Overdrive in their second Univac I which is currently being installed. The Overdrive concept and design was developed by Bernard L. Stock, Chief Engineer, and is now being coded into some production runs.

COMPUTING CENTER - UNIVERSITY OF KENTUCKY - LEXINGTON, KENTUCKY

During the first nine months of operation (October 1, 1958 - June 30, 1959) the University of Kentucky Computing Center machines were utilized as follows:

	All Machines		650	
	Hours	%	Hours	%
Agriculture	1517	30	374	15
Arts and Sciences	1733	35	1192	49
Commerce	478	9	345	14
Education	223	4	78	3
Engineering	124	3	80	4
Medicine	104	2	25	1
(Computing Center)	855	17	349	14
	5034	100	2443	100

Average monthly 650 utilization:

Instruction (and demonstrations)	37 hours
Debugging - Compiling - Testing	90 hours
Production	145 hours
Total	272 hours

Average monthly 650 maintenance 27 hours

The rather high initial utilization can be largely attributed to the availability of many fine programs and automatic programming.

COMPUTER KIT DEVELOPMENT - UNIVERSITY OF NEW MEXICO - ALBUQUERQUE, NEW MEXICO

Dr. Arnold Koschmann, Associate Professor of Electrical Engineering, working under a grant from the National Science Foundation, hopes to develop a digital computer kit for educational purposes. This kit would be suitable for high school use and hopefully would be sold for less than $1,000. The computer will have a stored program and will perform many of the functions of a larger computer at lower speed and with short numbers. Because of the cost of decimal input-output equipment and decimal to binary conversion equipment it is expected that this computer will be equipped with binary input and output on switches and lights.

The University welcomes any suggestions on ways to improve the performance and lower the cost of such a computer.

AEC COMPUTING AND APPLIED MATHEMATICS CENTER - NEW YORK UNIVERSITY - NEW YORK, N. Y.

The transceiver unit was removed in July. In September 1959, at the time of installing a 32,768 word core memory in the IBM-704, the Floating Point Trap will also be installed. The IBM installation will then have in addition to the central computer (with printer and punch), and the standard assortment of punchcard equipment: On line—ten tape units, one CRT unit (camera), one display tube; Off line—one tape to printer unit, one card to tape unit.

One and one half shifts of the IBM-704 operation is used for research, and an additional one and one half shifts is used by AEC contractors. One shift on the Univac is being used (mainly for research).

NAVAL AIR TEST CENTER - U. S. NAVAL AIR STATION - PATUXENT RIVER, MARYLAND

In August 1959 a Burroughs E101-3 Computer equipped with paper tape input and output was installed. The tape units have a capability of accepting or preparing a data tape which is compatible with the input requirements of the Datatron 204.

Also in August two Telereadex-Telecordex film reading systems were installed. The output of these systems is punched paper tape and is suitable for direct entry into the Datatron 204. The system is equipped with 35mm double frame film movement and a 20X Lens.

DATA PROCESSING CENTER - U. S. NAVAL SUPPLY CENTER - NORFOLK, VIRGINIA

The Norfolk Naval Supply Center is one of the largest in the world, carrying over 575,000 items of stock and serving nearly 2,000 ships. The Center is responsible for supplying the entire Atlantic and Mediterranean Fleets, and numerous shore establishments and is the main point for the Navy supporting the North Atlantic Treaty Organization. In an average month, the Center receives well over 200,000 request documents and ships out over 145,000 tons of supplies and equipment.

The massive flow of supplies from Norfolk Naval Supply Center is now being directed by a Burroughs 220 electronic data processing system. Providing routine decisions automatically, the computer will determine availability of items requested for shipment, create shipping invoices, and update stock and financial records. Prior to electronic processing, requisitions received from the Fleet and other customers will be screened, sorted by processing category, edited and coded. Punched cards will then be prepared, arranged in stock number sequence and

read into the system. The new system has been programmed to provide electronic management by-exception. During the processing run, the computer will check all input data against regulations which govern the handling of given transactions. Finding an exception condition, the computer will print an exception notification card. Notification cards will be sent to stock analysts, assuring that non-routine problems get immediate attention.

Routine print-out from the system will be in the form of invoices with attached issue data cards. Wherever possible, these will be produced in material location sequence. When warehouse and delivery action has been taken, the issue data cards will be returned to the Requisition Control Branch and filed as proof of delivery.

Replacing its bulky visual record system, the Center will compress its vast, 575,000-item inventory records to a Burroughs 220 magnetic tape system. The system will be comprised of single-tape units and multiple-bin Datafiles. Each Datafile provides rapid random access to over 50 million digits of alphanumeric data. In addition to the requisition application, the computer will also provide for material receipt transactions, financial accounting and integrated personnel accounting; and print up-to-the-minute reports to facilitate executive decisions. It will also be used to produce issue documents, transaction listings, stock and financial inventory control records, and regular management reports. Several additional applications are already under consideration.

For the Center to provide comprehensive supply support for high priority projects such as the Navy Ballistic Missile Program (POLARIS), immediate random access to up-to-the-minute status of stock records is necessary. The means to obtain the required information is being provided through the Center's new "telephone inquiry unit." Inquiries from center customers, technical bureaus, supply demand control points (inventory managers), and local operating personnel will be received by one of six telephone inquiry clerks who will fill out an interrogation form including the EDP System Search Key (Federal Item Identification Number) of the items under interrogation. The interrogation form will be passed to the Flexowriter-Photoreader operator. By means of a Flexowriter, the EDP System Search Key will be punched into paper tape which is fed into a Burroughs Photoreader. The Photoreader will scan the paper tape and transmit a signal to the data processor indicating that an interrogation is standing by. Upon recognition of this signal the data processor will activate the internally stored search program to seek the particular item record required. The answer to the inquiry will be printed out on an IBM 407 tabulator. If the item is carried in stock, the necessary stock status information will be printed out on the 407. If the item is not carried, the legend "NC" (not carried) will be printed out. The print-out form will pass to the telephone inquiry clerk who will relate appropriate information to the inquiring person.

The entire cycle, including original telephone conversation with the inquiring person, until the answer is returned to the telephone company has been estimated to require 73.4 seconds.

STROMBERG TRANSACTER SYSTEM - U. S. NAVAL WEAPONS ESTABLISHMENT - WASHINGTON, D. C.

The Naval Weapons Establishment (formerly the Naval Gun Factory), a job shop, manufactures prototype ordnance hardware and ordnance systems. Very little volume production is accomplished. Therefore, all manufacturing processes and all data recorded and used incident to these processes have to be built around a one time accomplishment. Put another way, they do everything once and nothing twice. Such a requirement for manufacturing, of necessity, creates large volume data recording operations and makes the cost accounting and cost distribution problem one of great complexity.

During the year 1956, intensive study was put on the problem of generating production control feedback reports on a daily basis to permit better control of manufacturing processes and to bring about better cost and labor distributions. It was found that for production control and cost distribution purposes, a manufacturing process completed by a man required the reporting of time, of elapsed time, of pieces completed, of machine groups, and various other types of data amounting to as many as sixty characters of information, most of which could be predetermined, but some of which were variable.

Coincidental with the above studies was a study being made pointing toward the introduction of electronic data processing. Although the two studies were unrelated, it became apparent that an answer to the problem of accurately recording the data required in connection with production control, and that of the introduction of this same data into a computer could be solved by one and the same approach. A need was felt for a system that could accurately transmit from the point of origin the data generated by a shop as it completed operations in the manufacturing process; this data to be recorded automatically in a form that could be introduced directly into a computer without any additional manual processing. Such is the Shop Recorder, or by its trade name, the Stromberg Transacter System.

The Shop Recorder system consists of two types of machine; a recorder or transacter that can be located at the work station in a shop, and a compiler that can be located in a shop office or other remote space. Original data is introduced into the transacter where it is transmitted to the compiler. Here the data is translated into standard 7 channel paper tape code. This paper tape can be made compatible with all present computers and computer systems.

The transacter, the machine located in the shop, is built to accommodate punched cards in any of 5 different combinations totaling not more than 124 characters in length. These cards can contain any repetitive data, that it is wished to report upon. In this case the data, for production control purposes, is a 15 column card to identify the man, a 22 column card to identify the job, and a 29 column card to identify the machine and machine grouping. The recorder also has 7 dials, each dial marked 0 to 9, for introducing variable input data. In Naval Weapons Establishment use, the first variable dial identifies the type of transaction being recorded. The remaining 6 dials can be programmed to report pertinent data compatible with the code set on the first dial (for instance, pieces completed on a regular manufacturing process, the reason for delay of a particular job, type of extra compensation that goes with the job reported upon, a code representing the reason for standby when charging time to an overhead account, etc.). The machine can also be programmed so that all data pertinent to the type of transaction being made is introduced or the machine will not transmit. (If, for instance, a regular production transaction is being reported the machine will not transmit unless both a man card and a job order card is introduced.) The machine also contains a yes or no button which in this case is used to indicate the transaction is to "report time involved" to set up a machine for piece production; this is the yes part of the switch. The no (or minus) indicated button is not currently used. It may be used at a later date to report adjustments (credits). To all the above data is added a two digit number indicating work area location, a two digit cost center number, a three digit time number, a one digit compiler number and a three digit day number.

When all data is properly introduced into the transacter, a transmit bar is depressed and the data travels at the rate of 60 characters per second over a 21 pair cable to the compiler, where is added to it the time in 10ths of hours and the date. A check is made automatically at this point for length of message (previously programmed into the compiler) and for parity. If either of these two conditions indicates an error, the compiler punches an error code into its paper tape message. Such an error is indicated by an error light back at the transacter. If an error is indicated at the transacter, the operator depresses his transmit bar a second time in an effort to retransmit correctly. If the message does not get through correctly on the second attempt it is proposed that a reason for the poor reception be investigated by a maintenance man, and the messages introduced via a manually prepared omission slip.

Accuracy and parity checks mentioned above extend through the mechanism actuating the paper tape punch. No means are provided to insure that a punch in effect produces a hole in the paper. This possibility is considered extremely remote.

The system is designed so that as many transacters as may be desired can be fed into a single compiler. The compiler will receive at the rate of 60 characters per second, and by means of an automatic switch will connect a transacter ready to transmit to the compiler; and while that transmission is taking place will search for and find a second transacter waiting to transmit. The number of transacters that may be used with a single compiler can be easily determined, given the number of messages required to be transmitted, their length, and the time available to transmit them. Each compiler has the capacity to address 36 transacters.

In summary, this system is designed to transmit data from its original source, in its original form, and translate this data into a punched paper tape, which can be immediately used without further manual processing by either present day tabulating equipments or present-day electronic computers. At the Naval Weapons Establishment this system is replacing the manual recording of data by shop personnel concerning manufacturing processes upon which they report, and the IBM keypunch operators used to translate this manually recorded data into cards for further processing in the tabulating equipment room. The transactor can be easily moved and can be readily located where data originates.

A study of the flexibility of the Shop Recorder system will readily indicate its adaptability to the accommodation of almost any data transmission and recording problem in existence. The Naval Weapons Establishment has plans for the use of this equipment in the recording of maintenance control data, and in the recording of supply transactions.

COMPUTATION CENTER - U.S. NAVAL WEAPONS LABORATORY - DAHLGREN, VIRGINIA

On 15 August 1959, the name of the Naval Proving Ground, of which the Computation Center is a part, was changed to the U. S. Naval Weapons Laboratory. This action reflects the changes which have occurred over the past decade in the station's mission and the character of its programs and research activities.

NORC. The regular work week has been increased from 120 to 136 hours to accommodate increased workload. Remaining time in the week is used for engineering changes necessary for installing the 20,000 word memory (see DCN, July 1959).

A Copyflo electrostatic printer has been installed for rapid reproduction of microfilm output from the high-speed Charactron printer/plotter attached to NORC. The printer (see DCN, Jan 1958 and July 1958) records on 35mm film any of 64 characters formed on the face of a Charactron cathode ray tube; any selected character may be centered on any of 1200 x 1200 discrete points in a rectangular array.

Several interesting subroutines have been developed for extending the usefulness of the printer/plotter. A continuous curve may be plotted by recording a succession of closely-spaced dots. In order that curves of uniform density may be produced, a subroutine has been written which causes a closely and uniformly spaced succession of dots to be plotted through datum points which may be widely spaced. Another subroutine produces, from a succession of points distributed in three coordinates, a pair of two-dimensional plots which can be viewed stereoscopically.

For certain applications such as printing mathematical equations and printing titles and legends on graphs, the 64 standard characters impose an undesirable limitation. A set of subroutines has therefore been prepared which control the production of additional characters by the technique of recording closely-spaced points. Presently included are oversize Roman and Greek caps and lower case letters, oversize numerals, mathematical symbols, punctuation marks, and miscellaneous other symbols. A Naval Weapons Laboratory report, "Subroutines for the NORC CRT Printer," describing the above subroutines will be issued shortly.

Satellite Surveillance. Satellite ephemerides are now being computed on NORC, using input values read from analog recordings of interferometric data received from stations in the satellite detection barrier (SPASUR system) by direct telephone lines. Development is in progress for a completely automatic digital data transmission and processing system.

A display device has been built which projects optically on a world map the positions of all known satellites (SPASCORE). Operation may be either in real time (minute by minute), or as an accelerated motion picture. Film for the projection is prepared by means of a NORC program, using the high-speed Charactron printer/plotter.

NAVAL MANPOWER INFORMATION SYSTEM - U. S. NAVY BUREAU OF PERSONNEL - WASHINGTON, D. C.

The Naval Manpower Information System which provides integrated data processing of naval personnel information previously consisted of two installations; one at Norfolk, Virginia and one at San Diego, California. In July 1959 this system was increased by the addition of a third installation PAMI CONUS (Personnel Accounting Machine Installation, Continental United States) located at Bainbridge, Maryland.

PAMI CONUS is charged with the accounting responsibility for 181,000 naval personnel. Some 30 items of essential information are maintained on each of these persons. Approximately 134,000 changes are processed to the tape files each month. File up-dating, processing, and timely and accurate personnel report production are greatly facilitated by the "PAMI CONUS" Tape 650 system installation which includes six IBM 727 Tape Units, and one 305 Random Access Memory Unit. Off-line output equipment includes two tape data selectors together with tape units, printers, and punches. Current studies and experience to date indicate operations in the neighborhood of 1-1/2 shifts per day.

ELECTRON COMPUTER BRANCH (CODE 280) - U. S. NAVY BUREAU OF SHIPS - WASHINGTON, D. C.

The Bureau of Ships Applied Mathematics Laboratory at David Taylor Model Basin expects to complete the installation of a UNIVERSAL DATA PROCESSING SYSTEM during January 1960. The system will have the following capabilities, leading to the rapid automatic transmission, recording, analysis, and presentation of data. 1. Acceptance at very high speeds and conversion by equipment of Electronic Engineering Company of California of input from any of the following media: punched cards, paper tape, direct or fm recording analog tape (1/2" 7-channel), binary tape (1" 14-channel), IBM 704 tape, UNIVAC I & II tape, IBM 705 tape, IBM 650 tape, UNIVAC 1103A or 1105 tape, and 8-bit straight binary tape. 2. Processing and analysis by: IBM 704 computer system, UNIVAC system, and LARC system (upon installation). 3. Rapid output (by use of Stromberg Carlson's SC 4020) in: graphical or chart form—including titles and grid lines, and printed report or tabular form. 4. Long range transmission to and from computer system.

During 1959 the Applied Mathematics Laboratory carried out the solution of the following significant problems on high speed computers: Motion of an elastic submerged mooring cable, Flexure of a submerged submarine ship antenna, Calculation of biologically significant gamma radiation, Response of a ship hull to a transient load, Lateral motion of a ship in oblique waves, Neutron distribution after an arbitrary number of scatterings, and Distance effects for counter-rotating propellers.

The largest data processing problem ever solved for the Bureau of Ships was successfully completed by the Management Data Analysis Division, Applied Mathematics Laboratory. Data on approximately 600,000 separate pieces of electronic equipment is processed each week.

Specifications for Flame, a three-dimensional reactor burnup code for the LARC system, have been completed.

COMPUTER CENTER - U. S. NAVY ELECTRONICS LABORATORY - SAN DIEGO, CALIFORNIA

In July 1959 a Burroughs 220 Cardatron system replaced the 205 system. An assembler, NELCA, has been developed for the 220 and is in operation.

A new compiler, NELCO, which employs the International Algebraic Language (see Comm. of the ACM, Dec. 1959) has been designed and coded for the Remington Rand Countess. While some features of IAL have not yet been implemented, the basic version of NELCO has been tested and in operation since July.

COMPUTERS AND CENTERS, OVERSEAS

THE CAROUSEL MEMORY - AB ATVIDABERGS INDUSTRIER - STOCKHOLM, SWEDEN

A novel type of random access memory system, described as a Carousel Memory, has been developed in Sweden. Data are recorded on short pieces of magnetic tape, which are wound around 64 separate spools. These spools are arranged in two concentric rows on a large wheel rotating on a horizontal axis. Each spool can rotate around its own axis. The wheel with its 64 spools is called a carousel. Each carousel unit has a storage capacity of about three million alpha-numeric characters. Both the spools and the carousel can easily be removed, which means that data can quickly be exchanged by changing the information-carrying medium as in a conventional magnetic tape unit. As a random access memory, the Carousel Memory System seems to be unique in this respect.

Selection is performed in three steps. First one carousel is selected. Then one of the spools is selected by means of turning the carousel until the desired spool is below the center of the carousel, which is then stopped. The carousel can rotate left or right in order to achieve the shortest possible access time. The free end of the tape is equipped with a small weight, which guides the tape to a magnetic head and a drive capstan, located below the carousel. A roller presses the tape against the capstan and the tape unreels downwards and is accumulated in a tank. The last step in the selection process is performed during the read-write operation while the tape is passing the magnetic head and specified blocks of information can be selected. The average access time is 1.9 seconds. Rewind starts automatically after each read or write operation. One spool houses about 8.5 meters of magnetic tape and the speed of the tape is five meters per second. There are eight channels of which one is used for checking. The magnetic head uses ferrite-cores and has been designed in such a way that an air gap is constantly maintained between the head and the surface of the magnetic tape. So called "drop outts" - one of the most serious problems in connection with digital magnetic tape recording - has thus been eliminated.

WREDAC MODIFICATIONS - THE AUSTRALIAN WEAPONS RESEARCH ESTABLISHMENT - SALISBURY, AUSTRALIA

In the Digital Computer Newsletter, July 1958, three extensions to the present WREDAC (WRE Digital Automatic Computer) were proposed; two of these have now been made. The machine order calling the first of these extensions into operation specifies the "Use B-lines" instruction under a general "use logic" order. The function digits of the order code specify a "use logic" operation, the three most significant binary digits of the address specify the type of logic to be employed, and the six least significant binary digits of the address specify the mode of operation in this logic.

When a "use logic" order which specifies a "use B-line logic" occurs, the six least significant binary digits of the address specify the type of B-line logic to be employed, the group of B-lines (from the four groups available) to be used, and the B-line in the group which will have the automatic counting facility.

The "use units" order remains the same as previously described and has been successfully employed in doubling the number of paper tape readers and paper tape punches. This order is also used extensively with tape unit operations, since it controls the switching of tape units to the independent input and output channels.

Double Length Accumulator. A double length accumulator has been installed on the machine in place of the original single length accumulator, without any major increase in the operation time of arithmetical or logical orders. This has been made possible by the operation of two single length accumulators in such a way that, overcarries on right shifting are placed in the accumulator containing the least significant part of a double length word during the operation of the function through the accumulator which contains the most significant part of a double length word.

Magnetic Tape Units. It is proposed to install four Ampex 1/2", eight track magnetic tape units in place of the present two 1/4" tape units. The new units will have a stop/start time of less than 5 milliseconds and will use asymmetric read/write heads. This latter arrangement, in conjunction with the "use unit" order, will allow checking of information immediately after it is written on the magnetic tape. The independent reading and writing channels available on the machine make this type of operation feasible, and the "use unit" order will provide the switching of a single read/write magnetic tape head to the reading and writing channels. The format recorded on the magnetic tape will consist of six information tracks and two clock tracks. A computer word will consist of six rows of six binary digits each, and its beginning and end will be marked by an appropriate coding of the two clock digits in each row.

In order to facilitate tape searching operations it is proposed to include in the transfer (i.e. interstore and input/output) order code two additional instructions. The first of these will prevent the reading of information from magnetic tape until an inter-record gap has been detected. The second will provide the machine with a means for detecting inter-record gaps without reading blocks of words. This order will provide a record skipping facility which can be obtained under program control.

High Speed Display. The automatic off-line binary to decimal converter and display unit for magnetic tape output from the computer will also be modified for an Ampex 1/2" magnetic tape unit. Facilities will be included in the control logic to allow for the selection of up to 16 words from a block of 64 words. This facility will reduce considerably the need to re-arrange records on magnetic tape by computer program.

CHARACTER READING - COMPAGNIE DES MACHINES BULL - PARIS, FRANCE

The most important problem of every manufacturer and user of calculators is the means of communication with the exterior of the machine. This problem of entry and exit vitally affects the efficiency, and depends not only on the specific performance of these units but also on the way in which information is supplied. Generally at the output a final document is printed. This information is ideal because the machine has produced a document which can be read directly by anybody. However, this is not true for the introduction of data and the reading of results which, having to serve as data in a subsequent stage of the work, must be re-translated into a form which the machine can read. In all these cases a coding system which can be read by the machine (but not easily by the employee) is used, for example, the punched card (although the card may be interpreted), punched tape, or even a type of coding that is not visible, magnetic tape. Another characteristic of these types of recording is that they resort to a strict method which cannot, in the case of punched tape or magnetic tape serve as the original document and in the case of the punched card constitutes a document which lacks flexibility of use.

Thus it becomes desirable to find a coding process which allows direct reading by machine and the human eye. The applications are normally those of bank cheques, money orders, postal orders, and debit and credit notes. However, they are not limited to banking. Other applications are found everywhere where a large number of documents must be circulated.

Different types of codes are in use at present. The majority use characters of a special form which are read either by a photo-electric process or by a magnetic process, the character in the latter case being printed with ink containing particles of magnetizable iron. This latter type of reading is in general preferred to the former because over-printing on the document - and this often occurs on cheques - does not in any way affect the reading. Thus it is to this type of reading that the Bull Company returned when perfecting a completely new system of direct reading.

The character used is, for the first time, a character with a completely normal form and which cannot be told at first sight from a normally printed character except that the strokes of which it is composed resemble the characters used by machines for certifying cheques. The user will not, therefore, see any difference between this character and an ordinary one. Furthermore, the reading will be checked automatically by the machine itself. There will thus be the certainty that what has been read by the machine has been correctly read. This is an essential check when dealing with a large number of documents that must be entered in an accounting system.

Reading and checking by the machine are extremely simple. This allows a fairly economical machine construction. A detailed examination of a Bull character reveals that it is composed of seven vertical lines of magnetic ink cut to form a figure. These seven lines of ink are separated by six spaces. Each space is 2/10 Cm., thus permitting up to 64 different combinations according to the arrangement within the figure of wide and narrow spaces. For example, when printing only figures, the characters used are composed of two wide spaces and four narrow spaces. The fifteen combinations thus obtained allow the printing of ten figures and five codes. At the same time the reading of these characters is automatically checked by a very reliable checking system similar to that used with punched tape. Each character must have at least two wide spaces and not more than two.

Another example illustrates the simplicity and security of this kind of reading which is done by the detection of "all or nothing," that is to say by the presence or absence of a magnetic spot. This is a simple and reliable process which avoids the machine having to interpret intermediate signals, for example, when there is "a little."

Another important innovation presented by the Bull apparatus is the possibility of extending the system to the direct reading of letters. This is an essential point which had not been envisaged for any of the machines so far studied. It is made possible here by the richness of the Bull type face where distinctive marks which can be read by the machine. It is acknowledged that direct reading is complete and of general application only when it is fully alphabetical.

The first prototype sorter has been presented by the Bull Machines Company which reads and sorts cheques printed with the compensation number of the bank on which the cheque was drawn, the number of the Agency, the account number and the amount of the cheque. An actual machine is in course of preparation. This will permit the swift sorting of cheques and the introduction of the data from these cheques into machines of varying capacities for the treatment of the information. Machines intended for the centralized and decentralized printing of these cheques are in course of preparation with assistance from different specialized manufacturers of keyboard machines.

COMPUTING LABORATORY - UNIVERSITY OF DURHAM - NEWCASTLE UPON TYNE, ENGLAND

The University of Durham Computing Laboratory was established in October 1957, and on 1 November 1957, a Ferranti Pegasus Computer was installed. The machine has been provided primarily for research and instruction in both the Durham and Newcastle divisions of the University, but a proportion of the operating time (currently about ten per cent) is available for hire to local industrial organizations. The time required by University users has doubled within the last six months. Engineers are in attendance from 8:30 a.m. to 5:30 p.m. After 5:30 p.m., the computer is operated unmaintained by qualified users and usually closes down about 10:00 p.m. If a persistent fault occurs during unmaintained time, the computer is switched off and a report left for the engineers. During the first year the machine was on for 2,529 hours and in the first 31 weeks of the second year for 1,880 hours. The average weekly efficiency during maintained time was 98.26 and 93.60 respectively. The second efficiency figure was considerably affected by a total down time of 20 hours during a 3 week period in February - March 1959.

The Computing Laboratory has a total staff of about 10 including the academic staff. The laboratory offers courses in programming, numerical analysis, and topics in operational research. Undergraduates are able to attend Autocode courses and to operate the machine on their own problems.

COMPONENTS AND SYSTEMS - ELLIOTT BROTHERS LTD. - LONDON, ENGLAND

Card Reader with Column Identification. The end-on card reader mechanism introduced in 1956 has been the subject of continuing development work. The latest model incorporates positive identification of columns by using specially printed cards. A set of index marks are printed on the back of the card along the bottom edge, and these are sensed by lamp and

phototransistor as the card passes under the main sensing station. The speed of reading is 400 cards a minute, and variants for 65 column and 80 column operation are available.

High-Speed Paper Tape Reader. A punched paper tape reader based on a design by the Cambridge University Mathematical Laboratory is now in production. Capable of reading at speeds up to 1000 characters per second, the tape can be stopped on any character, and entirely asynchronous operation is normally used. The sensing elements are Mullard OCP 71 phototransistors, and perspex light guides are used. The tape driving capstan runs directly on the shaft of the driving motor, and the tape is engaged against it by means of a pinch roller operated by a solenoid. The braking action is provided by a simple pressure pad attached to the armature of a second solenoid, and it is arranged that the braking tension is sufficient to over-ride the driving tension without straining the tape. The instrument measures 10-3/4" x 6-5/16" x 8-1/4" without tapehandling attachments.

Computing Service Conserves Hydro-Electric Power. The hydro-electric scheme has been simulated by the mathematical model which is being used to determine the efficacy of various means of increasing power output of the system. The programme operates in time intervals of one day and can represent the behaviour of the system over 14 years in about 35 minutes. The effect of different strategies for controlling water consumption is calculated to find maximum power output conditions and the programme can also be used to assess the effect of making physical alterations to the system.

Data-processing System for Japanese Bank. Nearing completion at Borehamwood is the 405 Data-processing system destined for the Sumitomo Bank in Osaka, Japan. It will be installed in January 1960, and is to be used for controlling the four-and-half million variable term loans on the books of the Bank.

ORION SYSTEM AND SIRIUS - FERRANTI, LTD. - LONDON, ENGLAND

Ferranti Ltd. have developed the Orion System to meet the needs of modern business for an electronic system which is reliable, fast, and which offers the following significant advances in data processing technique: Automatic time sharing and priority processing; Much faster magnetic tape operation than hitherto; Extensive and extendable magnetic core storage; Direct connection of the fastest available input and output equipment; Built in facilities for commercial arithmetic; Optional floating point facilities.

The Orion System uses the Neuron logical elements which have been proved in the successful Sirius computer. These elements enable complex systems to be built with a minimum of components and a maximum of reliability. The computer is fully transistorized. It is backed up by Ferranti's systems and programming services.

The system can accept and in turn produce data in all current commercial data processing media, in the form of paper tape, punched cards and high speed printing, and it handles a magnetic tape system operating at an extremely high speed.

The Ferranti Orion System can deal with information in all these forms and in such a way that the fullest use is made of all the equipment involved at all times. This is done by storing several programmes in the computer at once. While one programme is waiting for an input or output device to complete a transfer of information, the computer will be using the time on another programme. Similarly, whenever an input or output device is ready for its next operation, the computer switches to the appropriate programme to handle the information. This is achieved by incorporating into a fast transistorized magnetic-core-store computer special facilities, including:

A high speed built-in automatic time-sharing system.
Direct transfers of information between input and output devices and the store.
Automatic facilities for handling sterling amounts and for operating on fields corresponding to groups of columns on punched cards.
Thorough built-in checking of storage and of input and output transfers.
Extensive backing storage on magnetic drums.

All the equipments for input and output (hereafter called peripheral equipments) and also the auxiliary drum storage, are connected directly to the main magnetic-core storage system of the computer, in a uniform manner for all types of equipment. There are built-in facilities to ensure that programmes do not refer to parts of the main store in use by other programmes, or to parts of the store involved in a peripheral transfer between an input or output equipment and the store.

The high speed of the computer is matched by an Ampex magnetic tape system of comparable speed, operating very much faster than the magnetic tape equipment hitherto available.

The Orion system has been designed so that installations may grow gradually from a basic system. It is possible to add to the system at any stage - without invalidating existing programmes. Usually the first addition to be made will take the form of further peripheral equipment. Because many jobs will be limited by the speeds of available peripheral equipment, this means that more work can share the available time if more peripheral equipment is added to the system. Additional working storage or backing storage may also be added at any stage.

The computer and its magnetic tape system is so fast that it can take in stride the sorting operations for which punched card equipment had to be used previously. This speed ensures that such operations are carried out economically and accurately.

The Storage System. The computer has a magnetic core working store of capacity between 1,024 and 4,096 words, depending on requirements. It is intended to extend the storage up to 16,384 words. This store is backed by a number of magnetic drum units, which are treated as peripheral devices. A drum unit normally has a pair of 16,384 word drums with a mean access-time of 12 milliseconds, single-drum units can however be provided.

A word in the store may be regarded as equivalent to: a. A fourteen decimal digit number represented by 48 binary digits; b. Eight alphanumeric characters, each of 6 binary digits; c. One three-address instruction, or one modified two-address instruction. For those who also wish to have complete scientific computing facilities, equipment for fast automatic floating point operations is provided as an optional extra. In this case a word represents a floating point number corresponding to a precision of eleven significant decimal digits.

As many items of commercial information are quite short, special facilities are provided for packing more than one item into a word, and for extracting such items from a word.

The Peripheral System. Information may be transferred directly between any peripheral device and any strip of consecutive locations in the working store of the computer. When the transfer has been started it is completed under the control of the peripheral device while the computer goes on with other available work. There are special arrangements, known as lock-outs, to ensure that the computer cannot refer to a strip of locations being used for a transfer, or to a peripheral device which is currently carrying out a transfer. The following peripheral devices are being incorporated with the first Orion system being built: Drum Unit with two 16,384-word drums; Card Reader, Card Punch, Line Printer, of the latest proven types; Four Ampex FR 300 Magnetic Tape Units operating at a speed corresponding to approximately 45,000 80-column cards per minute in a typical case; Rank Xeronic Printer (3,000 lines per minute); Flexowriter typewriter with keyboard; Fast and Medium-speed Ferranti photo-electric paper type readers, TR7 at 1,000 characters per second, and TR5 at 300 characters per second; Fast and Medium-speed Creed perforating punches, 25 Tape punch at 33 characters per second, and 3000 Tape punch at 300 characters per second; Teletype punch at 60 characters per second.

The Time-Sharing System. The time-sharing system ensures that the computer is always doing useful work while peripheral transfers take place, and that peripheral devices are always kept working at their full speed.

Every time that a peripheral transfer is finished, and every time the computer attempts to refer to data involved in an incomplete transfer or to any equipment involved in such a transfer, then the time-sharing system processes the programme priorities in the store of the machine, and decides whether to continue the operation of the present programme or to switch to another programme. In general, the computer will switch to the programme of first

priority which is not waiting for the completion of a peripheral transfer. The priority scheme will usually be: 1. Programmes using peripheral devices that cannot be made to wait, such as the Xeronic printer. 2. Programmes using the slowest devices, such as the paper tape and card equipment. 3. Programmes using magnetic tape. 4. Programmes making only occasional use of peripheral devices.

The time-sharing system incorporates special equipment to ensure that the task of selecting programmes in accordance with the priorities is carried out as rapidly as possible. This is important because such selections may take place many times a second. The design of the time-sharing system has been the result of simulation studies carried out on the Pegasus computer. When Orion reaches the end of a problem, or of a batch of data (such as a pack of cards in a reader), it will not stop as previous computers would have done. In place of a stop order there is intentional entry to the "Monitor Routine." The Monitor Routine will carry out appropriate changes to the programme priority list, and continue with the remaining programmes or read in another. The priority-processing is fully automatic, as are the arrangements for ensuring that programmes do not interfere with one another. The programmer does not have to concern himself with these matters when writing his programme.

Programming. The order code of the computer has been devised to facilitate the use of the latest commercial automatic coding methods. With such methods statements written in English may be translated automatically directly into the machine's language. The time-sharing arrangements mean that it is no longer necessary for the programmer to devote a lot of his effort to ensuring that as much use as possible is made of transfer times. The solution of the timing problem also means that the efficient automatic coding of data-processing tasks is made possible.

Speed. The system is very fast, partly because the orders are obeyed in very short times, partly because orders are carefully chosen, and partly because of the high speed of the magnetic tape system. Typical examples of instruction times are as follows:

Add the contents of register 50 to the contents of register 100 and place the result in register 150 - 64 microseconds.
Add the contents of register 50 to the contents of a register in a list of registers beginning at register 100, the position of the register in the list being contained in register 150 - 68 microseconds.
Multiplication takes from 64 to 200 microseconds and division from 100 to 900 microseconds.

The conversion of an eight character field into binary takes at most 400 microseconds so that the whole numerical information on an 80-column card can be converted in under 5 milliseconds. Conversion in the reverse direction takes at most about 1,800 microseconds. These conversion times mean that with typical conventional card readers and punches, the computer itself is only occupied with conversion for less than 1.5 per cent of card reading time and 3 per cent of punching time.

Magnetic tape processing is at the rate of 89 microseconds per word, plus approximately 10 milliseconds stop/start time for each inter-section gap. The sections are of variable length. They will not normally correspond to data processing records but will usually be considerably longer. If for example, a tape file consists of 10-word records these might be grouped in sections of 25 records or 250 words. Such sections may be read or written at the rate of 1,800 sections per minute. As each 10-word record corresponds to the contents of an 80-column punched-card, this corresponds to a card reading speed of 45,000 cards per minute.

The SIRIUS computer (see DCN, July 1959) has a basic clock frequency of 500 kc. The number system is decimal, fixed point, with each digit being represented by 4 binary digits. Word length is 10 decimal digits, one word holding either a number or an instruction. Serial mode is used and one word time is 80 microseconds. The number range is $-.5 \leq x \leq +.5$. The computer has a multiple accumulator code and a modified single address code. Store is single level using magnetostriction delay lines.

The computing store is composed of magnetostriction delay lines each holding 50 words. There are 9 registers held on single word delay lines, one of these is the control register and

the others are X-registers or accumulators, all of which have full arithmetic facilities and any of which can be used as modifiers. All 8 accumulators and also the control register can be used as modifiers. Usually there are 1,000 words (20 delay lines) of storage but there are addressing facilities for up to 1,000,000 words. Access to the accumulators is immediate while access to ordinary registers may take 4 milliseconds. Checking circuits halt operations if a combination of digits representing a number other than 0 to 9 occurs. For monitoring, the instruction being obeyed is displayed on a set of 40 lamps while a second display is used to monitor any accumulator. There is a program stop and the machine can be operated manually.

The input is 5 hole paper tape using the Pegasus/Mercury tape code, with a speed of 300 characters per second and ability to stop on any one character. The output is 5 hole paper tape with a speed of 33 characters per second punching, or 10 characters per second for printing. There are input and output parity checks on decimal digits and other important symbols. The tape editing equipment is the standard set with Pegasus/Mercury keyboard and the usual copying, editing, and comparing facilities.

The order word structure is: register, 6 decimal digits; function, 2 digits; accumulator, 1 digit; and modifier, 1 digit. Multiplication order gives a double length unrounded product. For conditional jumps it is possible to test on any accumulator if $= 0$, $\neq 0$, ≥ 0, <0, and jump if OVR set/clear. There is an overflow indication with 2 of the jump orders.

Addition or subtraction takes 240 microseconds for numbers in X-registers and up to 4 milliseconds depending on access time for a number in another register. Multiplication takes a multiple of 4 milliseconds up to 16 milliseconds depending on the numbers involved. Other orders take between 240 microseconds and 4 milliseconds.

The computer is 10" deep, 81-1/2" long and 54-1/4" high. The control desk (standing on Roneo desk) is 24" deep 45" wide and 9" high. The weight of the computer (plus desk) is approximately 560 lbs. No special provision is necessary for power requirements as the computer operates from a standard 115 V 60 cps. 19 amp. supply. To date no special provision has been found necessary for voltage or frequency variation. Under normal conditions no cooling is required but a certain amount might be needed under tropical conditions. So far it has not been found necessary to make special provision for an alarm system.

INTERNATIONAL COMPUTERS AND TABULATORS LIMITED - LONDON, ENGLAND

International Computers and Tabulators Limited was formed in January 1959 as a result of the merger of The British Tabulating Machine Company Limited and Powers-Samas Accounting Machines Limited. I.C.T. manufactures a wide range of punched card machines using cards with capacities of 21, 40 or 80/160 columns. The range includes electronic calculators and medium scale computers, and work on a large scale computer is now proceeding. The integration of the two companies is almost completed and considerable expansion has been planned. Overseas subsidiary companies in most of Europe and Africa have already been formed and are functioning and a co-ordinating team is working on the rest of the world.

LEO II TEST - LEO COMPUTERS LIMITED - LONDON, ENGLAND

A system of acceptance tests for computers purchased by the British Government has been devised by the Technical Support Unit formed for advising Government Departments on technical standards of computers that they have under consideration. The first computer to be subjected to these tests was the LEO II delivered to the Ministry of Pensions and National Insurance at Newcastle, where initially it will carry out weekly payroll and monthly salaries and, subsequently, will produce statistical analyses based on benefit claims arising from sickness and accidents.

The equipment comprises a LEO II central computer (see DCN, April 1959) with a 2048 mercury delay line store, 16,000 word magnetic drum, and parallel on-line input and output devices. There are 3 concurrent punched card input channels, two punched card output channels, and a line printer.

The trials comprised 9 different tests, 5 of them diagnostic tests and 4 of them actual programmes from the payroll suite. The total running time of the set of tests was 115 minutes and the set was, therefore, repeated several times each day. The final analysis for the week, prepared by the Ministry referees, was:

	Hours
A. Test Running Time	37.74
B. Time lost owing to technical faults (including stoppage and re-run of test concerned)	.85
C. Time lost owing to data preparation or operating inefficiency	.90
D. Total time	39.49

The major criterion for the trial was in respect of the percentage of A/A+B. The efficiency attained was 97.8% which satisfactorily exceeded the required standard.

COMPUTING SYSTEMS - ROYAL DUTCH/SHELL GROUP - EUROPE

A review of computers in use or being installed within the Royal Dutch/Shell Group in Europe.

Holland. "Miracle," a Ferranti Mark I^{X} computer, is in use at the Koninklijke/Shell-Laboratorium, Amsterdam. "Miracle" is now in its fifth year of operation, the working-load being about 5000 hours per year. Besides the addition of an on-line printer (150 lines/minute) and a medium-speed punch (27 characters per second) in previous years, the storage facilities have recently been extended by the installation of magnetic tape equipment. Information on each of the two Electrodata tape decks (model 546) can be transferred in blocks of 128 twenty-bit words to the fast store via a buffer store and vice versa.

Shell Pernis Raffinaderij N.V. at Pernis, Holland has been using a Bull Gamma AET since February 1958. A second computer of the same type will be installed towards the end of 1959.

France. The Societe des Petroles Shell Berre in Paris installed a basic IBM 650 in January 1958. In the course of 1958 this system was extended by 6 magnetic tape units and an on-line 421 tabulator (150 lines/minute). A second 650 with tape units and on-line 421 tabulator is on order and will be delivered in March 1960. Since May 1958 another 650 has been in use in the office of the Bataafse Internationale Petroleum Maatschappij N.V. in The Hague. This equipment includes a floating decimal device, 3 index accumulators, and 4 magnetic tape units. An on-line 407 tabulator has been installed in the summer of 1959.

The refineries of the Compagnie de Raffinage Shell Berre at Berre and Petit Couronne in France, have each been using a Bull Gamma ET since February 1959.

United Kingdom. In the United Kingdom the refinery of the Shell Refining Co., Ltd. at Shell Haven is equipped with one HEC 4 computer and the refinery at Stanlow with two HEC 4 computers. These computers are manufactured by the British Tabulating Machine Co. A Ferranti Mercury Computer system is being installed at the office of the Shell International Petroleum Co. in London and will start operating in the autumn of 1959. This system consists of a basic Mercury with 4 drums, having a total capacity of 32,000 40-bit words, an on-line printer (150 lines/minute), and 5 Electrodata magnetic tape decks. The off-line equipment which will shortly be installed includes a card-to-magnetic tape and magnetic tape-to-card converter as well as an off-line printer.

SIEMENS 2002 - SIEMENS & HALSKE AG - MUNICH, GERMANY

The prototype of the Siemens Digital Computer 2002 (see DCN, April 1959) has been in operation since September 1956 and the first machine from this serial manufacture was put in operation in November 1958.

In May 1959 another Siemens Digital Computer 2002 was installed at the Rheinisch Westfälische Technische Hochschule in Aachen and one more Computer 2002 will be operating at the Hahn Meitner Institute for Nuclear Research in Berlin. This machine was flown to Berlin July 16 on a special Pan American Airways plane.

In the course of the next month some more Siemens Digital Computers 2002 will be installed at Scientific Institutes and Insurance Companies in Germany as well as in other European countries.

CAB 500 - SOCIETE d'ELECTRONIQUE AND d'AUTOMATISME - PARIS, FRANCE

The CAB 500 is a medium size general purpose digital computer, with alphanumerical programming and binary internal operation. It is ideal for medium size firms, universities, research and development laboratories, etc.; that is, for use where the amount of information to be handled does not require the use of high speed electronic computers with their inherent drawbacks and high costs.

The unit is in the form of a desk calculator requiring a floor space of about twenty square feet and is about thirty inches high. No special installation or cooling is required. The power requirements are approximately 1,500 watts from 3 phase 220 volts a.c. Little maintenance is required since the magnetic devices and associated transistor circuits which are the main elements of the computer unit have an almost unlimited life expectancy.

The 16,000 word magnetic drum rotates at 2,950 rpm which is approximately 20 milliseconds per revolution. The drum has 128 magnetic tracks and each is read by a magnetic head. These 128 tracks are divided into 129 sections of which only 128 are used. Each section contains a complete instruction which can be either a number or an instruction. On one half of these, tracks instructions have been permanently recorded and normally the user cannot alter this data. These stored instructions concern initial orders, conversion programs, and microprograms which make programming much simpler. The other 64 tracks are used to record the programs belonging to the given problem. In each of the 129 sections of one track, 34 binary digits can be recorded, 32 digits give definite information, the 33rd is used as a transfer parity check and the 34th is a free gap which is never used. A 33 digit group is called a "word" whether it is an operand or an instruction.

The computing unit is made up of two magnetic core shift registers directly connected to a parallel fast access store (2.5 microseconds access time) including sixteen 33 digits lines. The basic computing element is called the SYMMAG 200. This device is notable for its ruggedness, small size, low current requirements, and reliability. It consists of two square hysteresis loop magnetic cores and is both a regenerative and logical element. Logical operation "NOT" and "exclusive OR" are performed simultaneously and the results are given on two different output terminals. Any logical function, however complex, can be set up using one or more SYMMAG elements.

A FLEXOWRITER is the standard input-output device for the CAB 500. Other possible input and output devices are the S.E.A. 80 characters per second high speed tape reader and the 45 characters per second high speed tape perforator. The 500 may be connected to a magnetic tape handler (this computer series is CAB 600), when the amount of data to be processed exceeds the drum storage capacity.

A special machine feature is a push button "Machine de bureau" (Office calculator). This switch converts the general purpose computer into an office calculator by means of a special program which is fed into the machine whenever this button is depressed. All the mathematical functions remain operating but the instructions and information can be typed in directly in simplified form. The program is recorded in the computer and some operation cycles may be repeated with new instructions. The new instruction just has to be fed in and the computing process is repeated without external intervention. When operated in this way the system is far slower than a general purpose computer but there is the advantage that a programming specialist is not required for simpler problems.

About 700 SYMMAGS, 250 transistors, of which 144 are in the drum switching circuits, and several hundred semiconductor diodes are used in the system. The power supply is the only unit using vacuum tubes, but the specifications of these tubes are not critical since SYMMAGS are quite insensitive to voltage supply variations. The control of the electrically operated typewriter uses ten miniature type thyratrons.

CHARACTER RECOGNITION - SOLARTRON ELECTRONIC GROUP - FARNBOROUGH, ENGLAND

The Solartron Electronic Group Limited is currently manufacturing a machine which will read sales information printed by cash registers feeding a computer directly. The reading machine (E.R.A.) is due for systems test by late fall and delivery early 1960. Other applications are hire purchase and rental payments records in which the reader is to read receipt records and automatically create punched cards, and reading significance of handwritten marks. Future applications will be in reading meter records of Public Utilities, Public Transport traffic records, and separate document reading and sorting.

RESERVATION SYSTEMS - STANDARD ELEKTRIK LORENZ AG - STUTTGART, GERMANY

Airline Reservation Systems. The system consists of about 60 agent sets connected to a common central equipment. The distant agent depresses a few keys denoting a certain flight several weeks ahead; within two seconds he receives the answer as to the availability of seats for the desired flight. The answer appears as indicator lamp signals and covers alternate routes when the particular flight desired is no longer available.

The agent set comprises indicator lamps at the top, a space for inserting a flight chart in the center, and a keyboard on the lower portion of the panel. The agent inserts the flight chart pertaining to a particular route. The right-hand edge of the metal flight-chart carrier is notched, the arrangement of the notches forming a code automatically switching the central equipment to the flight route desired. The chart also has space to list alternate routes. First the agent depresses the keys for starting and landing places, date, and class, and finally the key ASK initiating the interrogation process.

There is one green and one red lamp over each of the 10 columns. Green means that seats may be booked for that flight while red means none available, see alternate routes. Red and green: Flight nearly sold out, refer to management. If no lamp lights for any one route, the flight is not scheduled or does not have the class desired.

Several agent sets may be connected by one junction box and multi-wire connections within the same building while the line between the junction box and the central equipment may be a two-wire or, also, a multiwire line. The junction box prevents interference by parallel-connected agent sets during the interrogation-and-answer time (between depressing the key ASK and lighting of answer lamps, usually 2 seconds, transmission time excluded). However, the answer lamps remain lit until switched off by the agent negotiating with the customer.

The central equipment consists of a modified "master" agent set with special capabilities of writing availability information into the storage unit (magnetic drum), the control equipment, and the power supply. Master sets may be operated from airports. To write information into the storage unit, the master-set operator inserts the flight chart and operates the keys just as in the case of the agent set. Upon depressing the release key REL, the information is transmitted to the storage unit.

In the case of the system supplied to SAS, the advance-booking period covers 70 days; hence, every evening a plug has to be withdrawn from the translator jackboard and plugged into the jack of the date 70 days ahead. In so doing, the operator releases an automatic process by which all information "red" and "green-red" becomes "green" for the new date. Any deviation from this program may be keyed in manually. If flight routes or timetables are revised, new flight charts (paper, glued to the metallic flight-chart carrier) have to be issued.

Two magnetic drums store the information elements keyed in for any given flight, day, and class as well as the cautioning information ("green + red"). Control circuits automatically signal to the agent set when the information should be repeated (lamp R), when the desired flight is outside the booking period (lamp NA) or when a failure disturbs operation (lamp US). The keys are interlocked to prevent double or faulty keying.

A distributor connects the individual agent sets to the control equipment to ensure prompt access to the stored information.

The flight charts are printed or typed on paper and glued to an aluminum carrier notch-coded for a general direction. Each flight chart has 10 vertical columns associated with the red and green lamps of the agent set. Each column may have three non-stop flights or one flight with up to 8 stops associated with the 9 airport-locating keys of the agent set. The maximum number of flight charts (corresponding to the number of general directions) is 100.

The storage unit contains 2,000 non-stop and multi-stop flights per week for a 70 day booking period. The storage consists of 2 magnetic drums, each having 320,000 bit capacity, 3,000 rpm rotation, 320 tracks and heads, 1 mm track spacing, and 1,000 bits per track.

The distributor has a maximum capacity of 100 agent sets or buffer registers. The date translator has 186 date jacks (for six-month cycle), and 70 plugs with cords (equal to the booking period in days). Transmission speed depends on the mode used: 2-wire telephone line, 100 bits per second; teleprinter line, 50 bits; multiwire, 1,000 bits. In 90% of the cases 2 seconds are required for the inquiry and answer (excluding transmission time).

The floor area of the desk-type agent set is 240 x 440 mm (10 x 18 in.), the size of the flight chart is 215 x 120 mm (9 x 5 in.), and the magnetic drum is 150 mm (6 in.) dia., 380 mm (16 in.) high.

Carferry Reservation System. The system enables booking offices all over Europe to book carferry reservations at a central office within 20 seconds by writing and reading a few teleprinted code groups. It was developed for the German Railroads running the ferries between Germany and Denmark, but it is available for other applications.

The booking office wishing to know 60 or more days ahead how many seats, berths, or car tickets are available for a given voyage, just needs to connect its teleprinter to the central office by dialing. The central office automatically writes the number of available tickets on the teleprinter in the booking office. After the booking office assistant has keyed in the number of tickets required by his customer, the central will subtract these tickets from the total number and confirm this operation by teleprinting to the booking office the new and the old number of tickets still available for that particular journey.

If the ship at, say, 0800 hrs. is sold out, the central will not only indicate this by teleprinting to the booking office the date, ship's number, and two zeros which, for the 10th day of January and ship or voyage No. 765 would read 1001 765 00, but also add information on available tickets for the next ship on the same day. If all routes on the desired day are sold out, the central will report 000, and if the date is outside the schedule at all, eee for "error." The booking officer may then, after consulting his customer, key in another date. The appearance of the total information typed might thus be:

(a)	1110 ffm r02
(b)	1503 765
(c)	1503 765 00 000
(a 2)	1110 ffm r02
(d)	1603 786
(e)	1603 786 49
(f)	952 -3
(g)	-46-49

A duplicate of this conversation is typed in the central by an automatically connected typewriter and records that on 11 Oct. the central at Frankfurt/Main (ffm), receiving unit r02,

answered a call (a). The booking office desired to know what tickets were available for the 15th day of March for trip, flight, route or ship 765 (b). The central answered: None, and added: and none for that day (c). The central then disconnected itself.

The officer conversed with the customer, dialed again, the central reported "ready for operation" (a2), and the officer demanded information on route 786 on the next day, March 16 (d). The answer was: 49 tickets available (e) whereupon the officer keyed the number of his office (952) and the number of tickets to be booked (-3) (f). The central then confirmed the order (g), again switching itself off subsequently. This switching-off also occurs if, after step (e), a pre-set time runs out before the customer makes a new decision. Returned tickets can be added to the total number available in a similar way.

In the central, all information is stored by a magnetic drum. Since the access time is much shorter than the conversation with the booking office, several buffer storages are provided for the automatic conversation and the magnetic drum is tapped only whenever required. The number of buffer storages depends on the number of booking offices that can communicate with the central. Interchangeable modules are provided for arithmetic operations. One bay is equipped with a jack-board for simple jumpering of the daily shift in advance booking period.

The characteristics, dimensions, and weights are variable within a wide range depending on customer's demand. The data given below refer only to the one installation supplied to the German railroads and was developed to their specifications. While an existing telex network is used, teleprinters forming the inputs and outputs to the central, the latter is the subject of the actual development. The floor area required for the six bays is 400 x 45 cm^2 (160 x 18 sq. in. approx.). Two bays contain the magnetic storage drum, the arithmetic modules, jack, fuse and indicator boards, and utilize a total of 3200 germanium diodes, 1700 germanium transistors, 4800 resistors, 1400 capacitors, and 40 relays. The other bays contain additional buffer storage and consist of 215 relays, 30 selenium rectifiers, 35 capacitors, and 40 resistors. The storage capacity of the magnetic drum exceeds the required 161,200 bits. 13 bits are required for each decimal two digit number (2-out-of-5 code groups for each digit + 3 bits for the self-checking operation). The self-checking operation ensures identification of the faulty bit.

This total number of storage cells was determined by 200 ship movements scheduled daily for 62 days ahead, with up to 99 tickets being available for each ship (200 x 62 x 2 = 24,800 two-digit numbers). The time required by access and calculation operations for one inquiry is 10.5 milliseconds on the average. This speed is very fast compared with the time (150 ms) required for the transmission of only one teleprinter character.

A control desk provided in the central allows manual key-in of new routes or to control the automatic writing of a large number of routes into the magnetic-drum storage.

BESK AND FACIT EDB2 - THE SWEDISH BOARD FOR COMPUTING MACHINERY - STOCKHOLM, SWEDEN

The BESK, in operation since 1953 (see DCN, April 1957), has been modified to include several new features adapting the machine to more general usage: 1. The reading of five-hole telex code and the writing of alphabetical text; 2. The choice of output-device, tape punch, or writing machine, formerly regulated by manual switching, may now be done by programming; 3. The operation speed has been accelerated, for example, "addition time" has been lowered to 42 from 58 microseconds; 4. BESK has been fitted with circuitry for high speed floating point operations. A new specific (revocable) order causes the machine to execute all untagged orders in fixed point and specifically tagged orders in floating point arithmetics. The system allows mixing of floating point and non-floating point arithmetics.

FACIT EDB2, a new machine of BESK-type produced by the Electronic Division of the Facit Enterprise, Stockholm, was installed at the Board in the second quarter of 1959.

Basic Features. Word length, 40 binary bits; instructions written in one address system, each word contains 2 instructions.

Operating Times. Addition, including access time, 45 microseconds (approx. 22,000 additions/sec.); Multiplication, including access time, 290 microsec. (approx. 3,450 multiplications/sec.); Division, including access time, 560 microseconds (approx. 1,800 divisions/sec.); Logic choice, including access time, 23 microseconds (approx. 44,000 choices/sec.).

Storage. The core memory holds 2,048 words, and the magnetic drum stores 8,192 words, divided into 256 channels with 32 words in each.

Input. Paper tape via dielectric high-speed reader, 500 characters (letters or figures) per sec. with the possibility of stopping anywhere between any two lines on the tape.

Output. Paper tape via high-speed perforator, 150 characters per sec. Electric typewriter (for control purposes), 12 characters per sec. Installation of two magnetic type stations for FACIT EDB2 will be finished in 1959.

In the last two years several systems for symbolic coding have been developed for BESK and FACIT EDB2. 1. FA-systems were given by G. Hellstrom, Data Consult, Stockholm. System FA5 provides coding with Fictitious Addresses. FA6 implies some interpretive features, and FA7 includes compiler function. 2. FLINTA pseudo coding, developed by G. Ehrling, chief mathematician of the Board, is an interpretive system for floating point arithmetics. The FLINTA-FA-system is a combined version of both systems. 3. ALPHACODING system, developed by Auto Code AB, Stockholm, provides automation of coding work in a more advanced manner. The pseudo code of the system is closely connected to e.g. mathematical expressions or other in principle arbitrary linguistic formulation; the system covers coding-requirements both for mathematical computing and for data processing and is in principle independent of machine type used. Close cooperation for further development of ALPHACODING has been established between Auto Code and the Board.

PC-1 - UNIVERSITY OF TOKYO - TOKYO, JAPAN

The PC-1 is a pilot model, binary, single-address computer installed at Department of Physics, Faculty of Science, University of Tokyo, and one of the first general purpose computers using parametron logic and two frequency magnetic core memory. Its construction was started in September 1957 and completed in March 1958. Its successful operation and high performance have lead to the construction of several larger computers based on the same design principle. Standard machine running hours are from 9:00 a.m. to 9:00 p.m. from Monday to Saturday. It is primarily intended for exploratory work on logical design and programming of computers, but about half of the time is made available to other laboratories in the university.

Memory. Magnetic core memory of the PC-1 uses sinusoidal waves rather than pulses for write-read operation. The core matrix consists of a 36 x 256 rectangular wire net. In each writing operation, a sinusoidal wave of frequency f/2 is put through the selected one of the 256 "row" wires, and the 36 information bits are applied to the 36 "column" wires in the form of the sinusoidal wave of frequency f, where the sign or phase of the latter wave represents each information bit. The cores on the cross points of both wires are subjected to the magnetizing force of the form $I_0 \cos \pi ft \pm I_1 \cos 2\pi ft$, and the asymmetry of this wave form causes magnetization of the core in one or the other direction.

The read-out of information is achieved by applying the current of frequency f/2 on a row wire and picking up the 2nd harmonic from the column wires.

The current of frequency f/2 is generated by special parametron elements used as frequency dividers. The selection of a particular row out of 256 is made by the threshold action of these parametrons against variation of the exciting current. The exciting inputs to these parametron frequency dividers are derived from a special multi-winding transformer called "polyhybrid." Each of its output winding forms 256 different types of linear superposition of the outputs of 18 power amplifiers, and the phases of these power amplifiers are changed in a definite way according to the bits specifying the particular address. In this manner, one and only one of the 256 parametrons receives a high input current, and all remaining parametrons receive current not more than 1/3 of the maximum value. This system, which is based on

the same principle as the error-correcting code, has the advantage that the machine operates correctly even in case of failure of 1 or 2 tubes in the power amplifier, and has proved superior both in economy and reliability.

Control. The design of the whole computer is based on synchronous philosophy. Control of the PC-1 is characterized by overlapping operation of different stages of successive instructions. The standard control sequence starts with the end pulse of the previous instruction (i-1). This causes reading of the operand of the next instruction (i), and decoding of the same instruction (i). At the end of the decoding operation, the operation pulse is emitted, which causes execution of the operation of the instruction (i), reading of the instruction (i + 1), and increasing the content of the sequence counter to i + 2. There are, of course, some exceptions in case of store instruction and other non-arithmetic operations. These overlapping operations have been very effective in increasing the speed of devices using perfectly synchronous circuit elements such as parametron.

Arithmetic unit. The arithmetic unit contains three 36-bit registers, A, R, and M. A and R are shifting registers and form a double length register for some arithmetic operations. A has a parallel adder used in all kinds of arithmetic and logical operations. The adder has a special high-speed carry network which enables the complete assimilation of carries in 36-bit addition in only 6 logical stages.

Overlapping input-output operation. Standard 6-unit teleprinter equipments (similar to Flexowriter) are used for input and output, together with a photoelectric tape reader. Since conversion to and from decimal scale is always done by program, special provision has been made to enable effective overlapping operation of input-output devices and the computer. The address part of every input-output instruction is a jump address, and when a particular input (or output) instruction is encountered and the input (output) device is not ready at the moment it is called for, the machine does not wait, but a jump takes place to that address. When any of these devices becomes ready, the normal program sequence is interrupted and control jumps to the address 511, while the address of the instruction which was to be executed next if the break-in did not occur is stored in the location 510. A special input-output executive program can take care of an effective overlapping operation of machine control and input-output devices by taking advantage of these facilities.

Summary Specifications. 4200 parametrons; number word, binary 18 bits (short word) or 36 bits (long word); instruction word, binary 18 bits single address, 27 different instructions; memory, magnetic cores, 512 short words; operation speed: addition and subtraction 270 microsecond; multiplication 2970, store 540, unconditional jump 270, negative jump 540; power consumption, 3 kva; floor area, 8 square meters.

READING MAGNETIC TAPE SLOWLY - ULTRA ELECTRIC LIMITED - LONDON, ENGLAND

Equipment has been developed for reading magnetic tape recordings of digital information at very slow speeds, or even when stationary. It is now possible to operate such devices as typewriters, teleprinters, paper tape punches, and card punches directly from magnetic tape.

The reading heads used are flux-sensitive, and a magnetic field adjacent to the reading gap causes an output due to changes in reluctance through the magnetic path in the head. Constructed in stack form the head caters for any track spacing. A typical specification is for an 8-channel head, reading half-inch tape with recording tracks 0.04 inch wide and separated by 0.02 inch. Staggered tracks can also be catered for.

Excitation for the flux-sensitive heads is supplied by an oscillator common to all reading gaps on a head. The frequency presently used is 100 kc but this may be increased in order to permit a higher maximum speed of reading, if this is required.

The slow speed reading system has already been applied to typewriters and teleprinters. The machine being driven is arranged to provide a feedback signal which controls the tape

transporter. This enables a typewriter or teleprinter to operate at its own maximum speed and ensures that no characters are lost during carriage return and line-feed operations.

The present equipment is capable of reading at all speeds from 0 to 10 kc, but there is no reason why the upper limit should not be increased. This may be required in cases where it is desired to search for a particular portion of tape and then print out the information contained thereon.

COMPONENTS

BIAX COMPUTING ELEMENT - AERONUTRONIC - NEWPORT BEACH, CALIFORNIA

The BIAX, a new magnetic computer element capable of multimegacycle performance in logical networks and memory arrays has been announced by Aeronutronic, a Division of Ford Motor Company. The element is a small rectangular bar of ferrite magnetic material measuring 50 x 50 x 85 mils. It represents a significant advancement in the state-of-the-art of magnetic computer elements and its application now makes possible the achievement of reliable high speed computing at a reasonable cost.

The basic concept employed is that of flux interference between orthogonal magnetic fields. This is accomplished by means of two 20 mil orthogonal holes through the element. The flux interference takes place in the magnetic material between the holes. Because of the orthogonality, no normal magnetic coupling occurs between conductors associated with the two holes in the materials. By controlling the spacing between the holes, the flux interference techniques can be made either destructive or non-destructive. Memory applications employ the non-destructive element whereas logical circuitry makes use of the destructive element.

In the memory element, one of the orthogonal holes acts as the storage axis while the other hole acts as the non-destructive interrogate axis. The BIAX logical element employs the same orthogonal hole technique, with the exception that the holes are placed extremely close together. Functioning as a memory element, the unit permits the reliable and economic realization of a very rapid random access memory unit. BIAX elements have been interrogated over one hundred billion times at a ten megacycle rate with no loss in output signal, indicating true non-destructive readout and low heating.

In addition to its ultra-high-speed memory capabilities, the memory element permits operation under extreme environmental conditions. A memory array has been operated for eight hours at 125 degrees Centigrade. Extensive environmental tests indicate that arrays can be fabricated which will operate in the vicinity of the Curie temperature of the ferrite used in their manufacture. Typical computer logical elements involve both gating elements and storage elements (flip-flops). Both types of logical elements have been successfully built and tested employing the BIAX principle. High speed operation up to 20 megacycles per second has been achieved by the use of these elements. Operational memory circuitry and logical circuitry have been fabricated and operated at two megacycles. Using this concept it is now possible to achieve computational equipment where the memory access time is properly matched with the logic processing speeds.

BIAX elements are currently being produced by mass production techniques. In production, BIAX computing equipment will be considerably cheaper than current equipment. This arises primarily because of the economies achieved in the logical devices where relatively cheap BIAX elements will replace expensive semiconductor devices. Present estimates indicate the cost saving will be at least a factor of 10 with regard to logical devices.

Because of their favorable environmental characteristics, the elements may be densely packed and thus permit achievement of extremely small volume, considerably smaller than is possible with semiconductor techniques. Two-hundred flip-flops and 3000 gates — the equivalent of 15,000 to 20,000 semiconductors — can be packaged in 1/10 of a cubic foot. The application of BIAX techniques will reduce the number of solder connections in a typical computer by a factor of 10 to 100, because many elements may be linked by a single wire, thus avoiding the

large number of solder joints necessary when semiconductor devices are used. The number of connectors will also be reduced by a factor 10 or more. Because of the smaller currents required to operate the BIAX memory, the total power required to achieve a given computational speed is materially reduced. Reliability of the elements is high. Their basic passive nature plus general rugged physical nature and insensitivity to temperature generally enhances the reliability by a large factor.

BIAX techniques are currently being applied by Aeronutronic to a number of airborne and ground-based military projects where multi-megacycle data processing is required.

ELECTRONIC CHARACTER GENERATOR - A. B. DICK COMPANY - CHICAGO, ILLINOIS

A. B. Dick Company of Chicago is offering a compact electronic character generator for converting binary-coded pulsed signals into alphanumeric video signals. Basically developed for converting six-channel parallel digital code into signals adapted to drive the electrostatic printing tube of their Videograph high-speed printing equipment, it also may be used as an efficient and relatively inexpensive means to display alphanumeric data on a conventional TV receiver or oscilloscope tube. The equipment is packaged in three 4" x 12 " x 13-1/2" standard modules comprising (1) Monoscope Character Generator Unit #300, (2) Monoscope Companion Unit #313, and (3) Monoscope Character Generator Power Supply #320. Incoming pulses into the companion unit are standardized with respect to amplitude, duration, and shape and directed to a 4" monoscope tube in the character generator chassis where they are used to selectively sweep an aluminum target having an 8 x 8 array of printed characters of symbols of any pre-determined type face. Voltages applied to the monoscope deflection plates are developed across voltage-reference diodes driven from constant current sources to provide inherent stability and freedom from drift. The second emission current derived from the monoscope target results in a video signal which is then amplified and used to modulate the beam of the output CRT or electrostatic printing tube. Basic conversion rate of the standard equipment is 10,000 characters per second, and modified version can be supplied to 20,000 characters per second.

HIGH SPEED PUNCHED PAPER READER - DIGITRONICS CORPORATION - ALBERTSON, LONG ISLAND, NEW YORK

The model 3500 DYKOR photoelectric reader is a completely solid-state unit which stops before the next character at reading speeds of 1000 characters per second. The fast stop is made possible by a unique design feature which has essentially eliminated mechanical motion involved in stopping the tape. Made to meet the requirements of accuracy, reliability and speed of digital computer input, machine tool control, or ground support equipment, the reader offers a wide range of versatility to the user. All standard 5, 6, 7, or 8-level tapes plus sprocket may be handled interchangeably merely by a simple setting of the tape guides. Both dual and single speed units operating at 100 to 1500 characters per second are available. To insure reliable, consistent, reading levels, only silicon photo-diodes are used, providing stability over wide temperature ranges. To further guarantee long trouble-free operation, the light source is considerably derated.

Modular construction provides a standard unit which enables the user to specify only those features which he requires. Thus various stages of amplification are available for both input control signals and output data signals. Outputs are also provided, if desired, with gated amplifiers and shaper circuitry. Tape motion can be controlled by either a DC or pulse input. The reader mounts on a standard 19" rack and takes up 7" of space. Power requirements are 115 volts, 60 cps, 180 watts.

TAPE VERIFIER - FRIDEN, INC. - SAN LEANDRO, CALIFORNIA

The Flexowriter Tape Verifier consists of a Flexowriter automatic writing machine and a cable-connected Motorized Tape Reader. As a document is typed on the Flexowriter, a by-product

tape is punched simultaneously. This original tape is inserted in the cable-connected Motorized Tape Reader. The same document is again typed on the Flexowriter. As each character is keyboarded, its assigned code is compared with the code in the original tape in the Motorized Tape Reader. If the two codes compare, the punch will operate and punch the verified code in the new tape. If the codes do not compare, the punch will not operate and the keyboard will lock. The operator must determine whether the error is contained in the original tape in the Motorized Reader or in the second typing. She then presses the Over-ride Switch on the front panel of the Flexowriter to unlock the keyboard and types the correct character. The correct code is punched in the second, or verified tape. The Motorized Tape Reader keeps pace with the fastest typist and will lock the keyboard only when the two corresponding codes fail to compare.

As a standard feature, the 8-channel Flexowriter Tape Verifier contains a Parity Code Checking device on the punch, wired to check for either odd or even bits in the code. If the codes all contain odd bits, for example, and through some punch failure an even bit code is punched in the tape, the keyboard will lock and an indicating light will glow. The operator must press the Over-ride Switch to unlock the keyboard, delete the incorrect code in the tape and continue typing.

LFE BERNOULLI-DISK MEMORY - LABORATORY FOR ELECTRONICS, INC. - BOSTON, MASSACHUSETTS

A new data storage technique was announced in December by the Laboratory for Electronics, Inc. of Boston. The new device will be known as the LFE Bernoulli-Disk. Its development was the result of a research program to solve the fundamental problem of reliable head to medium separation, and to provide the computer industry with a replacement for the conventional, universally-used, high-speed, medium-capacity magnetic drum. Objectives of this program included: elimination of costly and treacherous close-tolerance head-mounting; reliably reducing head-medium separation for shorter wavelength recording; substantial increase in compactness and decrease in weight; and the withstanding of stringent environmental conditions. The Disk utilizes, in part, principles of fluid motion derived from the conservation of energy in liquids and gases first discovered in the early eighteenth century by Swiss Scientist, Daniel Bernoulli. Principles of fluid motion are used to maintain a controllable and small separation between the storage medium and the read/write heads of the memory unit.

The unit consists of a flexible mylar magnetic disk that is rotated close to a smooth stabilizing backplate in which read/write heads are imbedded flush with the smooth surface. The tape disk is attached by flanges directly to the shaft of an electric motor, and an air-inlet orifice is located at the center of the backplate so as to permit air to enter between the rotating disk and the stabilizing plate. When the tape disk is at rest, it falls away from the backplate; but in motion, the limp disk becomes flattened by centrifugal force and the disk pumps air through the orifice and out at the disk periphery. At this point the hydrodynamic forces of the air between the disk and the stabilizing plate together with the dynamic and elastic forces of the revolving disk, cause the disk to conform to the backplate at a controllable and small separation.

The advantages offered by the Bernoulli-Disk over the conventional magnet drum are:

1. Reliability. Due to the low mass of the revolving disk and the positive separation maintained between disk and backplate, possibilities of damage to the read/write heads or the recording medium are virtually eliminated.

2. Shock-Resistance. The low mass of the recording disk provides a device which will stand extreme shock.

3. Low-Power. The device can be constructed to operate with extremely low power requirements and could be operated off Solar Cells.

4. Size and Weight. The size and weight of the Bernoulli-Disk is only a fraction of that of a conventional drum.

5. High-Speed. Due to the low mass of the revolving disk and the close control of separation, it is possible to operate the new device at speeds greater than the 10,000 rpm maximum of the conventional drum.

6. Temperature. The device will operate over a wide temperature range, and is designed to meet advanced military temperature specifications, including rapid change of temperature.

7. Low-Cost. A most important advantage of the Bernoulli-Disk in these days of rising hardware costs is its simplicity and extremely low cost - achieved through elimination of all need for complex machining.

These advantages, have all been demonstrated by actual laboratory tests. A recorded track of sinusoids at several hundred wavelengths per inch, for example, showed no serious amplitude modulation, even when the apparatus was pounded violently on a bench. Other laboratory experiments have indicated excellent stability including tape dimensional ability in test models operating in excess of 1000 hours continuous duty. Stop-start cycling experiments have demonstrated no appreciable wear to heads or tape after 3,000 cycles. The potential universality appears to exceed even the initial expectations of the scientists responsible for its development. Staff members of the Storage Device Group of the Computer Products Division now are exploring application of the device to a wide variety of information storage problems covering the whole field of ground and airborne digital computers - particularly equipments designed for missiles, spacecraft and satellites, where the Disk is the simplest rotating memory device ever developed that can meet the shock and environment conditions there encountered. The Bernoulli-Disk is a proprietary development for which patents have been applied. This development has now reached a stage where Laboratory for Electronics is prepared to develop disks for customized application.

MAGNETIC FILM MEMORY - LINCOLN LABORATORY, M.I.T. - LEXINGTON, MASSACHUSETTS

A high-speed magnetic film memory is now in operation as a part of the TX-2 digital computer at the M.I.T. Lincoln Laboratory. Its performance has been entirely satisfactory since its installation in July 1959. It has a capacity of 32 ten-bit words, suitable for evaluation testing, and serves as an experimental prototype for larger units. This new memory, and the TX-2 computer of which it is a part, were developed by Lincoln Laboratory under Air Force contract, with the joint support of the Army, Navy, and Air Force.

The read-and-write cycle time of 0.8 microseconds is consistent with the speed of the computer itself, although bench tests demonstrated successful operation at a cycle time as short as 0.4 microseconds. Net driving current for writing is 150 milliamperes, and one-millivolt output signals are obtained from individual memory elements.

Each memory element is a circular spot of Permalloy film (82 percent nickel, 18 percent iron) 750 Angstroms thick, 1.6 millimeters in diameter, centered 2.5 millimeters apart. The spots are deposited by evaporation on a flat glass substrate, 0.1 millimeter thick, in 16 x 16 unit arrays.

A thin film memory has several potential advantages over the familiar ferrite toroidal core memory; faster cycle time, lower power dissipation, greater compactness, and simpler fabrication. The unit now in operation confirms these expectations, although none of these factors has been fully exploited in this first developmental model.

UNIVERSAL MAGNETIC LOGIC ELEMENT - STANFORD RESEARCH INSTITUTE - MENLO PARK, CALIFORNIA

A new multi-apertured magnetic logic element has been developed at Stanford Research Institute under the sponsorship of the Office of Naval Research, Information Systems Branch. This device is a universal logic element in the sense that general digital logic may be performed with an appropriately wired array consisting of elements of this single type only. The

new element belongs to the family of magnetic multi-aperture devices (MADs) developed at SRI for use in diodeless shift registers as well as for more-complex logic units. Its primary distinguishing characteristic is that it was specifically designed to provide either direct or complementary transfer of binary information, depending only on a small difference in the mode of wiring. Small quantities of these elements have been fabricated by ultrasonic machining of ferrite disks. Pairs of them have been connected in closed loops, and bistable performance in their various modes of operation verified.

Future work on these devices will be directed toward improvement of the detailed design so as to obtain wider operational tolerances, and modification of the logical design to improve fan-in and fan-out capability.

MISCELLANEOUS

CONFERENCE - AUTOMATIC COMPUTING AND DATA PROCESSING IN AUSTRALIA - SYDNEY, AUSTRALIA

The Australian National Committee on Computation and Automatic Control announces a Conference on "Automatic Computing and Data Processing in Australia" to be held 24 to 27 May, 1960, at the University of Sydney and the University of New South Wales.

This Committee was recently formed as an association of professional societies interested in the use of automatic computing machinery. Its purpose is to assist in disseminating knowledge about this rapidly developing science. The Conference will bring together those actively engaged in computing in Australia, to report their current activity and discuss related topics.

Papers are now invited for consideration in the following broad fields: Commercial Data Processing; Construction and Logical Design (including Analogue Computers); Scientific and Engineering Computation; Scientific and Engineering Data Processing Techniques; and Equipment Offering in Australia.

It is expected that the volume of papers will be such as to require the holding of simultaneous sessions in different fields, thereby ensuring a specialized audience in each field.

Those interested in presenting a paper at the Conference are asked to submit to the "paper Sub-Committee," as soon as possible, a title and brief statement describing the classification under which the paper should fall. A summary (approximately 200 words) must be submitted by 1 February 1960.

Papers being submitted for reading at the Conference should be submitted to one of the professional journals for publication, since there will be no separate proceedings of the Conference published. This should be done prior to the Conference in order that preprints may be arranged. The Secretary will be happy to answer any enquiry concerning publication difficulties.

Enquiries and correspondence should be addressed to: C.H.D. Harper, Secretary, Australian National Committee on Computation and Automatic Control, c/o The Institution of Engineers, Science House, 157 Gloucester Street, Sydney, Australia.

HANDBOOK FOR AUTOMATIC COMPUTATION

Preparation of a handbook for automatic computation, in five or more volumes, is now under way for publication by Springer-Verlag. It will appear in F. K. Schmidt's series, "Grundlehren der Mathematischen Wissenschaften." Editors are: F. L. Bauer, Mainz; A. S. Householder, Oak Ridge; F. W. J. Olver, Teddington; H. Rutishauser, Zurich; K. Samelson, Mainz; R. Sauer, Munich; E. Stiefel, Zurich.

The purpose of the handbook is to provide a collection of tested algorithms for mathematical computations of all sorts: the solution of finite and of functional equations, methods of approximating functions, the evaluation of special functions, etc. These algorithms are to be written in Algol, hence will be usable on any machine for which a suitable translator is available, and even without a translator can be used as a model for programming. It is evident that such a collection could have no general utility unless written in some common program language. The descriptive language will be English.

As plans now stand, the organization of the series will be as follows: Volume 1a will contain a description of the use of Algol, and Volume 1b a description of the structure of translators. These introductory volumes are the only ones that will not be made up primarily of actual algorithms. Volume 2 will be devoted to the solution of finite equations, linear and nonlinear, including the determination of characteristic values and vectors of matrices. Volume 3 will be on functional equations, especially differential equations, ordinary and partial, and integral equations. Volume 4 is concerned with methods of approximation, and Volume 5 the evaluation of particular functions. It is possible that certain algorithms, such as those for solving inequalities, for mathematical programming, for statistical computations, and the like, that do not seem to fall naturally in any of these areas, may be reserved for a sixth volume. Each algorithm is to be accompanied by enough explanatory information to make it understandable, along with whatever information is available on speed, accuracy, range, or, more generally, for judging the effectiveness of the algorithm for a given type of problem. In any event, only pretested algorithms will be published.

Before the appearance of the volumes themselves, the algorithms will be prepublished in a series of supplements to the journal, "Numerische Mathematik." This is partly to make generally available each algorithm at the earliest possible time. But, in addition to this, it provides the possibility for including in the handbook itself additional information, and even corrections, that might come in from users.

Contributions are earnestly solicited. For the present, at least, these must necessarily be in the form of actual algorithms, along with information as to the extent and mode of testing the algorithm, estimates of accuracy, and experience in using it. Untested algorithms will not necessarily be rejected ipso facto, but their use must necessarily await actual test. As algorithms are published, information relating to published algorithms also will be welcomed. Contributions may be sent to any of the editors named above.

CONTRIBUTIONS FOR DIGITAL COMPUTER NEWSLETTER

The Office of Naval Research welcomes contributions to the NEWSLETTER. Your contributions will assist in improving the contents of this newsletter, and in making it an even better medium of exchange of information, between government laboratories, academic institutions, and industry. It is hoped that the readers will participate to an even greater extent than in the past in transmitting technical material and suggestions to this Office for future issues. Because of limited time and personnel, it is often impossible for the editor to acknowledge individually all material which has been sent to this Office for publication.

The NEWSLETTER is published four times a year on the first of January, April, July, and October, and material should be in the hands of the editor at least one month before the publication date in order to be included in that issue.

The NEWSLETTER is circulated to all interested military and government agencies, and the contractors of the Federal Government. In addition, it is being reprinted in the Communications of the Association for Computing Machinery.

Communications should be addressed to:

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